



Performance of bitter gourd (*Momordica charantia*) hybrids for growth and yield attributes in the northern coastal region of Andhra Pradesh

B SRINIVASULU^{1*}, S S VIJAYA PADMA², L NARAM NAIDU², M PARATPARA RAO²
and CH KIRAN KUMAR³

College of Horticulture, Dr. Y S R Horticultural University, Venkataramannagudem, Andhra Pradesh 534 101, India

Received: 6 August 2023; Accepted: 20 June 2025

ABSTRACT

The present study was carried out during summer and rainy (*kharif*) season of 2022 at College of Horticulture, Dr. Y S R Horticultural University, Venkataramannagudem, Andhra Pradesh to find out the best performers among various parents and cross combinations for growth and yield traits in bitter gourd (*Momordica charantia* L.). Seven parents were maintained in a parental block (Summer, 2022) and crossed in a half diallel mating pattern in order to produce 21 F₁ crosses, respectively. The crosses namely, IC-469512 × Special Boldar, IC-433630 × Special Boldar, IC-44418 × IC-469512 recorded highest vine length while IC-44418 × IC-433630 and Kashi Mayuri × IC-433630 were earlier in flowering. The hybrids, IC-44418 × IC-469512, IC-469512 × Special Boldar, IC-68314 × IC-469512 were found best for yield parameters compared to the standard checks Pragathi and Monarch. Preethi × Special Boldar shown longest fruit length and diameter whereas the hybrids IC-469512 × Special Boldar and Preethi × Special Boldar produced more number of seeds/fruit. Before being suggested for commercial release, the identified promising crosses and hybrids for earliness and yield-related traits may be further assessed in yield trials across the locations and seasons to confirm their potentiality and to determine their stability over various agro-climatic conditions.

Keywords: Assessment, Cross combinations, Fruit length, Seed per fruit, Yield

Bitter gourd (*Momordica charantia* L.) is a major commercial cucurbitaceous vegetable grown all throughout India in the summer. It belongs to the family Cucurbitaceae's subfamily Cucurbitodeae, tribe Jolffaeae, and tribe Thalithaneae. It is a diploid species with a somatic chromosomal number of $2n = 22$. Eastern Asia, most likely Eastern India or Southern China, is the bitter gourd's center of origin, according to Walters and Decker-Walters (1988), Miniraj *et al.* (1993). After that, it spreads widely over areas including Tropical Africa, North and South America, China, India, and Malaysia. The other species of *Momordica* include *M. balsamina*, *M. cochinchinesis*, *M. dioca*, *M. denudate*, *M. macrocarpa*, *M. subangulata*, and *M. tuberosa*. In spoken languages, it is also referred to as bitter cucumber or balsam pear in English, karela in Hindi, Gujarati, and Punjabi, pavakai in Tamil and Malayalam, hagalakayi in Kannada, kakarakaya in Telugu, tita kerela in Assamese, and karot akhabi in Manipuri.

Bitter gourd is one of the most prized vegetables among cucurbits because of its medicinal qualities and high nutritional content, especially in iron and ascorbic acid (Behera 2010). 100 g of fruit contains 82.2 g of moisture, 10.6 g of carbohydrates, 2.1 g of protein, 1.7 g of fiber, 23.0 mg of calcium, 38.0 mg of phosphorus, 171.0 mg of potassium, 2.4 mg of sodium, 2.0 mg of iron, 0.2 mg of copper, 0.1 mg of manganese, 0.5 mg of zinc, 126.0 mg of vitamin A, and 96.0 mg of vitamin C (Gopalan *et al.* 1993). The fruits are commonly consumed in many forms such as boiled, pickled, preserved, dried like vegetables, or packed with fried material.

Despite its excellent nutritional content, wide range of genetic variability in aspects of sex expression, growing habitat, maturity, and fruit form, size, colour, and surface texture, and widespread popularity among producers and consumers (Robinson and Decker-Walters 1997). Due to the usage of locally unimproved cultivars and severe infestations of insect pests and diseases, India continues to lag behind other countries in terms of bitter gourd yield. The most important stage is to identify better heterotic F₁ hybrids in terms of yield, quality, and earliness. Hybrids can increase production, earliness, uniformity, quality, and resistance to pests and diseases. In addition, there is a significant imbalance between supply and demand, with estimations

¹Vignans Foundation for Science, Technology and Research, Vadlamundi, Andhra Pradesh; ²College of Horticulture, Dr. Y S R Horticultural University, Venkataramannagudem, Andhra Pradesh; ³College of Horticulture, Dr. Y S R Horticultural University, Pravathipuram, Manyam, Andhra Pradesh. *Corresponding author email: srinivasbiyyala333@gmail.com

for the demand for bitter gourd reaching 193 million tonnes by 2030. The identification of suitable hybrids and the development of high yielding varieties was one possible strategy for achieving the targeted productivity.

MATERIALS AND METHODS

The present study was carried out during summer and rainy (*kharif*) season of 2022 at College of Horticulture, Dr. Y S R Horticultural University, Venkataramannagudem (16°63' 120" N and 81°27' 568" E; an elevation of 34 m amsl), Andhra Pradesh. The site is located in the humid agro-climatic zone 10, east coast plain and hills (Krishna-Godavari zone). The area receives 900 mm of rainfall on average. The region experiences hot, humid summers and mild winters. Seven paternal lines were crossed in a half-diallel fashion in all possible directions, removing reciprocals and generating twenty-one single crosses. Reciprocal crosses were avoided since it was assumed that there would not be a maternal influence in the experimental material. The seven parents which were part of the study are included in Supplementary Table 1 along with the acquired accession number. The five randomly selected plants from each replication were selected and data for growth and yield traits like vine length (cm), days to first male flower appearance, days to first female flower appearance, days to first picking, number of fruits/plant, average fruit weight (g), yield/plant (kg), fruit length (cm), fruit diameter (cm), internodal length (cm), seed/fruit and sex ratio were recorded.

RESULTS AND DISCUSSION

Analysis of variance: To determine the significance of the differences between the treatments, the analysis of variance of means was utilized. Supplementary Table 2 includes the data for the analysis of variance for means.

It was evident that each of the 12 traits under evaluation were significantly different.

Per se performance of parents and crosses: Table 1, 2 and 3 provided the data on mean performance of parents, crosses, and standard checks, respectively.

Growth attributes: The maximum vine length in bitter gourd offers an added advantage due to an increase of flowering nodes and yield. Among parents, vine length ranged from 171.11 (Preethi) to 231.51 (Special Bolder) whereas for hybrids, it is ranged from 180.44 (Preethi × Kashi Mayuri) to 286.53 (IC-68314 × Special Bolder). However, a mean vine length of 207.55 and 210.39 was recorded by the standard checks Pragathi and Monarch (Table 1 and Fig. 1). Shorter internodal distance can accommodate more number of fruits in a given height of the plant and will ultimately lead to higher production. It ranged from 4.85 (IC-433630) to 6.22 (Special Bolder) for the parents and from 3.71 (Kashi Mayuri × IC-44418) to 6.92 (Preethi × Special Bolder) for the hybrids. The standard checks, Pragathi and Monarch recorded a mean internodal length of 4.59 and 4.81. The highest vine length was observed in crosses namely, IC-469512 × Special Bolder, IC-433630 × Special Bolder and IC-44418 × IC-469512. Similar results obtained by Kumar *et al.* (2020) in bitter gourd.

In bitter gourd, earliness is a useful character for realizing the potential economic yield in a short time. On an average, 39.51 days after sowing were taken for the appearance of first male flower, which ranged between 35.78 to 45.36 days (Table 1). Among the parents, the range varied from 36.27 (Kashi Mayuri) to 44.56 days (IC-469512) while in hybrids, days to first male flower appearance ranged from 35.78 (IC-44418 × IC-433630) to 45.36 days (IC-433630 × IC-469512) and 40.03, 39.56 days were recorded in standard checks Pragathi and Monarch. On an average, 44.60 days after sowing were taken for the appearance of first female

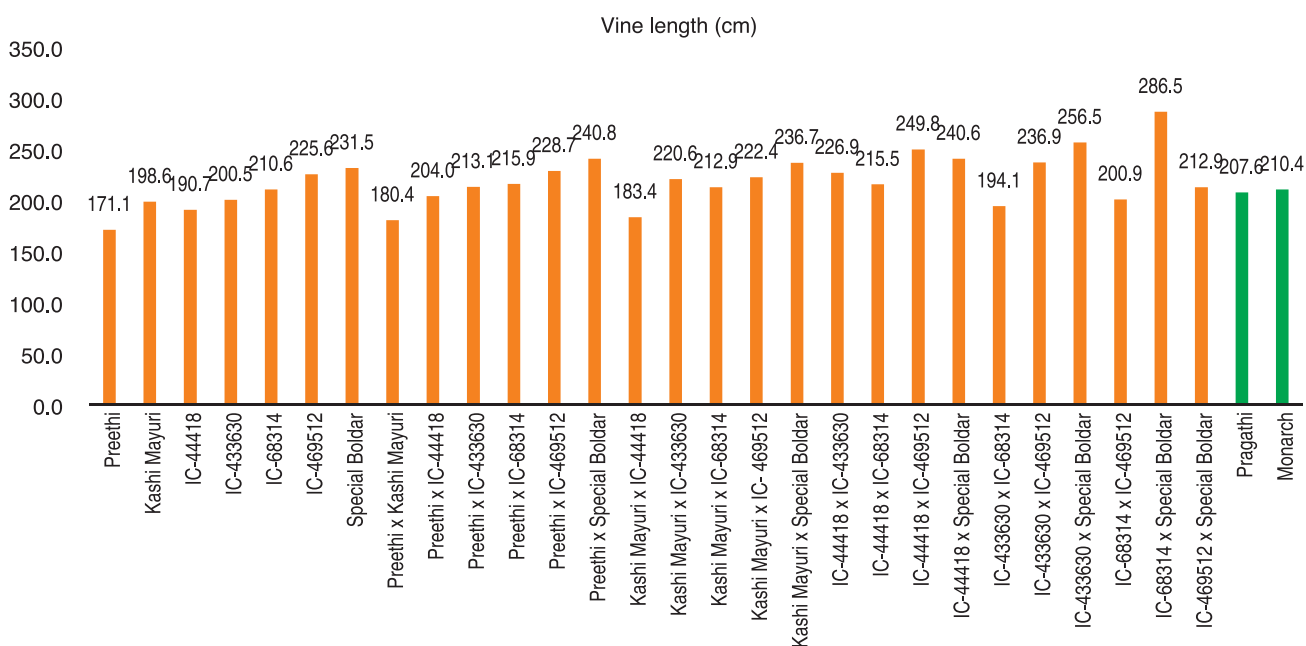


Fig. 1 Variation in vine length among the treatments under study.

Table 1 Mean performance of parents and hybrids for vine length, internodal length, days to 1st male flower appearance and days to 1st female flower appearance in bitter gourd

Treatment	Vine length (cm)	Internodal length (cm)	Days to 1 st male flower appearance	Days to 1 st female flower appearance
Parents				
Preethi	171.11	5.43	38.76	45.67
Kashi Mayuri	198.56	4.91	36.27	45.78
IC-44418	190.67	5.99	37.56	43.67
IC-433630	200.45	4.85	40.37	47.89
IC-68314	210.56	5.84	39.02	41.07
IC-469512	225.56	5.99	44.56	47.87
Special Boldar	231.51	6.22	37.89	46.02
Parents mean	204.06	5.60	39.21	45.42
Crosses				
Preethi × Kashi Mayuri	180.44	3.91	37.05	44.34
Preethi × IC-44418	203.98	4.31	38.52	43.36
Preethi × IC-433630	213.07	5.80	39.67	43.98
Preethi × IC-68314	215.87	4.72	38.65	46.83
Preethi × IC-469512	228.67	5.95	43.87	45.93
Preethi × Special Boldar	240.78	6.92	39.45	46.76
Kashi Mayuri × IC-44418	183.40	3.71	38.23	42.46
Kashi Mayuri × IC-433630	220.61	6.03	36.25	41.68
Kashi Mayuri × IC-68314	212.89	4.02	40.56	43.56
Kashi Mayuri × IC-469512	222.35	4.28	42.48	46.98
Kashi Mayuri × Special Boldar	236.67	5.08	40.78	45.63
IC-44418 × IC-433630	226.90	5.13	35.78	43.98
IC-44418 × IC-68314	215.45	4.13	40.45	43.96
IC-44418 × IC-469512	249.78	5.90	38.98	40.87
IC-44418 × Special Boldar	240.64	4.54	37.07	42.82
IC-433630 × IC-68314	194.11	4.29	40.89	44.68
IC-433630 × IC-469512	236.94	5.88	45.36	48.03
IC-433630 × Special Boldar	256.47	4.47	36.76	39.84
IC-68314 × IC-469512	200.86	5.42	42.67	48.92
IC-68314 × Special Boldar	286.53	6.56	38.83	40.75
IC-469512 × Special Boldar	212.86	4.44	39.07	47.82
Crosses mean	220.25	5.02	39.59	44.44
Checks				
Pragathi	207.55	4.59	40.03	44.98
Monarch	210.39	4.81	39.56	41.78
Grand mean	215.7206	5.13	39.5130	44.5970
SEM ±	3.2033	0.0662	0.5427	0.6359
CD ($p=0.05$)	9.0681	0.1874	1.5364	1.8002
CD ($p=0.01$)	12.0651	0.2493	2.0442	2.3951
Range	171.11 to 286.53	3.71 to 6.56	35.78 to 45.36	39.84 to 48.92

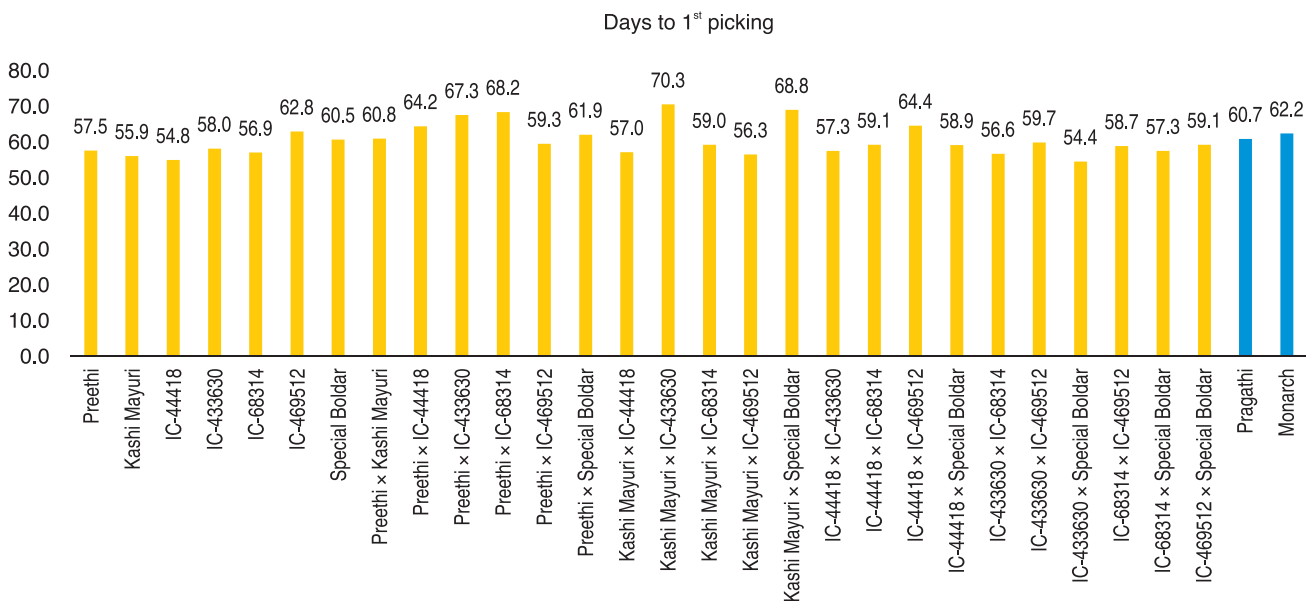


Fig. 2 Variation in days to first picking among the treatments under study.

flower, which ranged between 39.84 to 48.92 days (Table 1). Among the parents, the range varied from 41.07 (IC-68314) to 47.87 days (IC-469512) while in hybrids, days to first female flower appearance ranged from 39.84 (IC-433630 x Special Boldar) to 48.03 days (IC-433630 x IC-469512) and 44.98, 41.78 days were recorded in standard checks Pragathi and Monarch. The number of days taken to first picking ranged from 54.36 to 70.34 with an overall mean of 60.26 (Table 1). The days to first picking among parents (Fig. 2) was in the range of 54.78 (IC-44418) to 62.76 (Special Boldar). The hybrids, recorded 54.36 (IC-433630 x Special Boldar) to 70.34 days (Kashi Mayuri x IC-433630) to produce the first fruit as compared to 60.72 and 62.19 days recorded by the standard checks Pragathi and Monarch.

To achieve higher yield, synchronized flowering and low sex ratio (male to female) is desirable, which was obtained

when number of female flowers are more. The range of sex ratio among the parents and hybrids was from 5.25 to 13.56 with a grand mean of 9.56. Among the parents, minimum sex ratio was recorded in IC-469512 (7.10), while the maximum was recorded in Preethi (12.45). Among the hybrids, minimum and maximum sex ratio was recorded in IC-68314 x Special Boldar (5.25) and IC-433630 x Special Boldar (13.56). All the hybrids except five have recorded the lowest sex ratio than the standard checks Pragathi and Monarch (10.56 and 9.45).

The early flowering and fruiting were recorded in the hybrids, IC-44418 x IC-433630, Kashi Mayuri x IC-433630, IC-433630 x Special Boldar and Kashi Mayuri x IC-469512, respectively. The results were in conformity with the findings of Gangadhararao *et al.* (2017), Bhatt *et al.* (2017) and Ahmad *et al.* (2018) in bitter gourd.

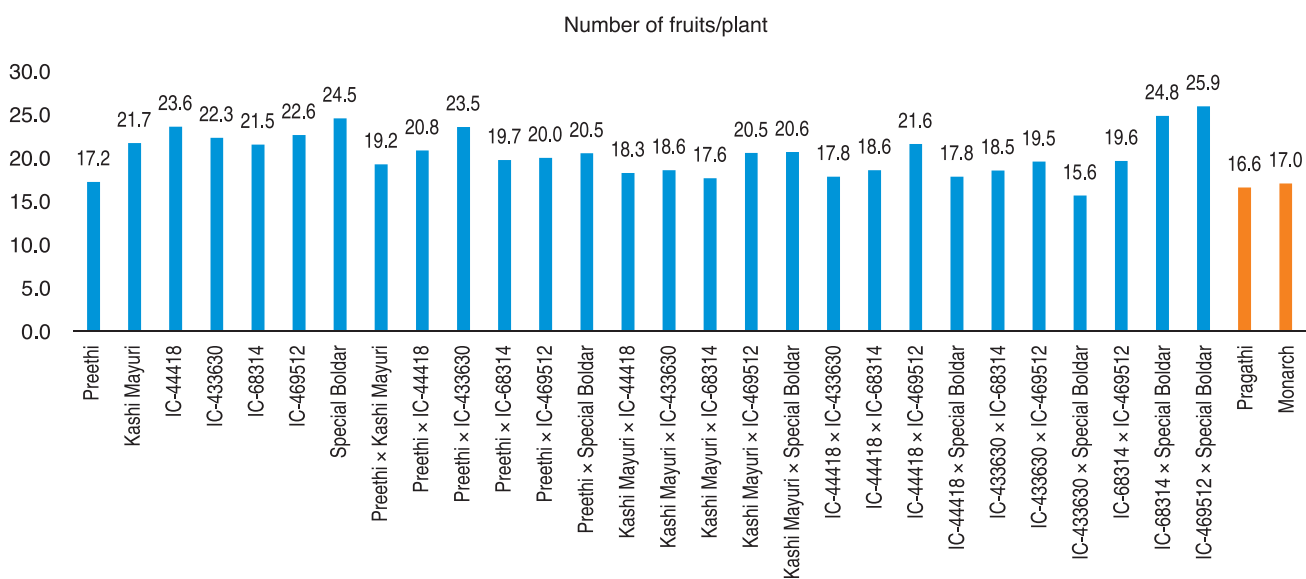


Fig. 3 Variation in number of fruits/plant among the treatments under study.

Table 2 Mean performance of parents and hybrids for days to first picking, number of fruits/plant, average fruit weight and yield/plant in bitter gourd

Treatment	Days to first picking	Number of fruits/plant	Average fruit weight (g)	Yield/plant (kg)
Parents				
Preethi	57.45	17.20	36.42	0.63
Kashi Mayuri	55.90	21.67	40.62	0.88
IC-44418	54.78	23.58	41.52	0.98
IC-433630	57.99	22.30	37.53	0.84
IC-68314	56.87	21.50	40.63	0.87
IC-469512	62.76	22.62	54.62	1.24
Special Boldar	60.54	24.54	20.56	0.73
Parents mean	58.04	21.92	40.13	0.88
Crosses				
Preethi × Kashi Mayuri	60.75	19.23	41.52	0.80
Preethi × IC-44418	64.23	20.82	43.56	0.90
Preethi × IC-433630	67.34	23.54	39.67	0.93
Preethi × IC-68314	68.23	19.72	44.22	0.87
Preethi × IC-469512	59.34	19.98	53.58	0.77
Preethi × Special Boldar	61.89	20.50	50.57	0.87
Kashi Mayuri × IC-44418	56.98	18.25	40.02	0.73
Kashi Mayuri × IC-433630	70.34	18.56	51.89	0.76
Kashi Mayuri × IC-68314	59.03	17.62	44.89	0.79
Kashi Mayuri × IC-469512	56.34	20.53	61.47	1.26
Kashi Mayuri × Special Boldar	68.79	20.64	28.98	0.71
IC-44418 × IC-433630	57.34	17.80	45.18	0.69
IC-44418 × IC-68314	59.06	18.57	41.54	0.77
IC-44418 × IC-469512	64.37	21.57	65.87	1.42
IC-44418 × Special Boldar	58.94	17.82	36.86	0.66
IC-433630 × IC-68314	56.56	18.52	39.62	0.73
IC-433630 × IC-469512	59.73	19.54	49.82	0.83
IC-433630 × Special Boldar	54.36	15.62	34.56	0.54
IC-68314 × IC-469512	58.68	19.62	60.67	1.19
IC-68314 × Special Boldar	57.34	24.82	60.87	1.01
IC-469512 × Special Boldar	59.06	25.92	63.52	1.27
Crosses mean	60.89	19.54	46.72	0.92
Checks				
Pragathi	60.72	16.56	40.35	0.58
Monarch	62.19	17.02	38.42	0.65
Grand mean	60.2626	19.9116	43.1301	0.8591
SEM±	0.9830	0.2938	0.5529	0.0135
CD ($p=0.05$)	2.7829	0.8317	1.5651	0.0381
CD ($p=0.01$)	3.7026	1.1066	2.0824	0.0507
Range	54.36 to 70.34	15.62 to 25.92	20.56 to 65.87	0.54 to 1.27

Table 3 Mean performance of parents and hybrids for fruit length, fruit diameter, seed per fruit and sex ratio in bitter gourd

Treatment	Fruit length (cm)	Fruit diameter (cm)	Seed per fruit	Sex Ratio
Parents				
Preethi	19.27	5.32	14.52	12.45
Kashi Mayuri	21.72	4.81	20.54	10.52
IC-44418	22.62	5.87	12.47	8.65
IC-433630	22.97	4.75	15.76	9.62
IC-68314	21.67	5.73	16.46	10.99
IC-469512	20.62	5.87	15.67	7.86
Special Boldar	7.35	6.10	12.06	9.21
Parents mean	20.66	5.49	15.35	9.90
Crosses				
Preethi × Kashi Mayuri	24.72	3.83	15.82	11.45
Preethi × IC-44418	21.23	4.23	15.96	7.98
Preethi × IC-433630	24.92	5.69	16.96	8.67
Preethi × IC-68314	21.34	4.63	17.14	8.89
Preethi × IC-469512	23.24	5.83	15.98	10.37
Preethi × Special Boldar	23.23	6.78	18.02	6.38
Kashi Mayuri × IC-44418	20.82	3.64	9.62	9.65
Kashi Mayuri × IC-433630	23.42	5.91	13.47	8.29
Kashi Mayuri × IC-68314	20.92	3.94	14.57	9.87
Kashi Mayuri × IC- 469512	22.87	4.20	16.67	6.26
Kashi Mayuri × Special Boldar	12.76	4.98	11.97	7.87
IC-44418 × IC-433630	17.56	5.03	12.42	12.23
IC-44418 × IC-68314	18.94	4.05	15.99	9.32
IC-44418 × IC-469512	17.26	5.78	17.53	5.69
IC-44418 × Special Boldar	16.47	4.45	14.87	12.86
IC-433630 × IC-68314	18.52	4.20	14.52	9.86
IC-433630 × IC-469512	20.77	5.76	17.62	10.04
IC-433630 × Special Boldar	12.32	4.38	9.54	13.56
IC-68314 × IC-469512	19.62	5.31	16.62	8.96
IC-68314 × Special Boldar	21.46	4.23	18.22	5.25
IC-469512 × Special Boldar	19.86	4.35	18.42	8.21
Crosses mean	19.13	4.92	15.32	9.41
Checks				
Pragathi	17.06	4.00	11.62	10.56
Monarch	16.56	4.25	12.05	9.45
Grand mean	19.3317	5.0041	15.0922	9.5646
SEM±	0.3199	0.0804	0.2118	0.1283
CD ($p=0.05$)	0.9055	0.2276	0.5995	0.3631
CD ($p=0.01$)	1.2048	0.3028	0.7976	0.4831
Range	7.35 to 24.92	3.64 to 6.78	9.54 to 18.42	5.25 to 13.56

Yield attributes: Number of fruits/plant is one of the most important characters as it directly contributes to yield. The parents and hybrids ranged from 15.62–24.82 with a general mean of 19.91 (Table 2 and Fig. 3). Among the parents, Preethi produced the lowest number of fruits (17.20/plant) and Special Boldar recorded the highest (24.54/plant). The number of fruits produced by hybrids were in the range of 15.62 (IC-433630 × Special Boldar) to 24.82 (IC-68314 × Special Boldar). All hybrids, except IC-433630 × Special Boldar and Preethi × Special Boldar (15.62 and 16.50 fruits/plant, respectively) recorded higher number of fruits/plant over the standard checks Pragathi and Monarch (16.56 and 17.02), respectively. Fruit weight is one of the yield component characters which directly influences fruit yield. The average fruit weight among the parents and hybrids varied from 20.56 to 65.87 with a general mean of 43.13 g. The range of average fruit weight for parents varied from 20.56 (Special Boldar) to 54.62 g (IC-469512). The hybrids had an average fruit weight of 28.98 (Kashi Mayuri × Special Boldar) to 65.87 (IC-44418 × IC-469512). All the hybrids, except Kashi Mayuri × Special Boldar (28.98 g respectively) recorded more average fruit weight compared to the standard checks Pragathi and Monarch (40.35 and 38.42) (Supplementary Fig. 1).

Fruit yield is the ultimate and most important trait. Fruit yield is the product of simultaneous manifestation of heterosis for yield attributing traits in general and fruit characters (length, diameter, weight and number of seeds etc.) in particular. The mean fruit yield of parents and hybrids ranged from 0.63–1.42 with a general mean of 0.86 kg (Supplementary Fig. 2). The fruit yield of parents varied from 0.63 (Preethi) to 1.24 kg (IC-469512). The hybrids recorded a range of 0.54 (IC-44418 × Special Boldar) to 1.27 kg (IC-469512 × Special Boldar). Increase in number of fruits/plant coupled with weight of the fruit would lead to the improvement in yield per plant. Highest fruit yield was identified in the crosses, IC-469512 × Special Boldar, Kashi Mayuri × IC-469512 and IC-44418 × IC-469512. Kandasamy (2015), Tiwari *et al.* (2016), Verma *et al.* (2016) and Kumar *et al.* (2020) also reported the similar results.

Fruit length and diameter contributes positively to the yield. The parents and hybrids recorded a mean fruit length ranging from 7.35–28.23 with a general mean of 19.33 cm (Table 3). Among the parents, it ranged from 7.35 (Special Boldar) to 21.72 cm (Kashi Mayuri). In hybrids, the fruit length varied from 12.32 cm (IC-433630 × Special Boldar) to 24.92 cm (Preethi × IC-433630). All crosses, except four crosses have produced fruits longer than that of standard checks Pragathi and Monarch (17.06 and 16.56 cm). The data on fruit diameter indicated a range of 3.64 to 6.78 cm among the parents and hybrids with a general mean of 5.00 cm (Table 3). The fruit diameter among the parents varied from 4.75 cm (IC-433630) to 6.10 cm (Special Boldar). Among the hybrids, fruit diameter ranged from 3.64 (Kashi Mayuri × IC-44418) to 6.78 cm (Preethi × Special Boldar). All hybrids except Preethi × Kashi Mayuri and Kashi Mayuri × IC-44418 (3.83 and 3.64 cm) have recorded higher fruit

diameter than that of the standard checks Pragathi and Monarch (4.00 and 4.25 cm). The results were in agreement with the findings of Mahamud *et al.* (2015), Kandasamy (2015) and Tiwari *et al.* (2016).

The seed per fruit varied from 9.54–18.42 with a general mean of 15.09 (Table 3). The parents exhibited a range of 12.06 (Special Boldar) to 20.54 (Kashi Mayuri). The number of seeds produced by hybrids were in the range of 9.54 (IC-433630 × Special Boldar) to 18.42 (IC-469512 × Special boldar). Excepting Kashi Mayuri × IC-44418, IC-433630 × Special Boldar and IC-469512 × Special Boldar (9.62, 9.54 and 10.42), all hybrids have recorded more number of seeds/fruit than the standard checks Pragathi and Monarch (11.62 and 12.05). The contribution of seed number towards improvement of yield was reported by Gupta *et al.* (2006), Laxuman (2005), Sundaram (2006) and Thangamani *et al.* (2011) in bitter gourd.

All the hybrids studied have recorded significantly higher yields over checks Pragathi and Monarch. The crosses IC-44418 × IC-469512, IC-469512 × Special Boldar, IC-68314 × IC-469512, Preethi × IC-433630 and Preethi × Special Boldar were observed to be the top most yielders. These crosses also have shown good response to number of fruits/plant, fruit length, average fruit weight and recorded higher values for other important yield contributing characters.

REFERENCES

- Ahmad A, Behera T K, Munshi A D, Bharadwaj C and Jat G S. 2018. Exploiting gynocercous line for earliness and yield traits in bitter gourd (*Momordica charantia* L.). *International Journal of Current Microbiology and Applied Sciences* 7(11): 922–28.
- Behera T K, Behera S, Bharathi L K, John K J, Simon P W and Staub J E. 2010. Bitter gourd: Botany, horticulture, and breeding. *Horticultural Reviews* 37: 101–41.
- Bhatt L, Singh S P, Soni A K and Samota M K. 2017. Studies on heterosis in bitter gourd (*Momordica charantia* L.). *International Journal of Current Microbiology and Applied Sciences* 6(7): 4069–77.
- Gangadhararao P, Behera T K, Munshi A D and Brihama D. 2017. Estimation of genetic components of variation and heterosis studies in bitter gourd for horticultural traits. *Indian Journal of Horticulture* 74(2): 227–32.
- Gopalan C, Rama B V and Balasubramanian S C. 1993. *Nutritive Value of Indian foods*, 2nd edn. National Institute of Nutrition, IGMR, Hyderabad.
- Gupta N, Bharadwaj M L, Singh S P and Sood S. 2015. Correlation and path analysis of yield and yield components in some genetic stocks of bitter gourd (*Momordica charantia* L.). *SABRAO Journal of Breeding and Genetics* 47(4): 475–81.
- Kandasamy R. 2015. Heterosis in bitter gourd (*Momordica charantia* L.). *The Asian Journal of Horticulture* 10(1): 158–60.
- Kumar V, Mishra D P, Yadav G C and Babu U. 2020. Studies on genetic component analysis and gene action for growth, yield and yield attributing traits of pumpkin. *International Journal of Chemical Studies* 6(2): 2695–99.
- Laxuman S, Patil A, Salimath P M, Dharmatti, P R, Byadgi A S and Nirmal Y. 2005. Heterosis and combining ability analysis for productivity traits in bitter gourd (*Momordica charantia*

- L.). *Karnataka Journal of Agricultural Sciences*. **25**(1): 9–13.
- Mahamud H, Rashid M D, Nazim U, Islam R and Asaduzzaman. 2015. Heterosis studies in bitter gourd. *International Journal of Vegetable Science* **22**(5): 1–9.
- Miniraj N, Prasanna K P and Peter K V. 1993. Bitter Gourd *Momordica* spp. *Genetic Improvement of Vegetable Plants*. Pergamon Press, Oxford, United Kingdom.
- Robinson R W and Decker-Walters D S. 1997. *Cucurbits*, pp. 1–206. CAB International, Wallingford, Oxford, United Kingdom.
- Sundaram V. 2006. Studies on character association in bitter gourd (*Momordica charantia* L.) under salt stress. *The Asian Journal of Horticulture Research* **5**(1): 99–102.
- Thangamani C, Pugalendhi L, Sumath T, Kavitha C and Rajashree V. 2011. Estimation of combining ability and heterosis for yield and quality characters in bitter gourd (*Momordica charantia* L.). *Electronic Journal of Plant Breeding* **2**: 62–66.
- Tiwari N K, Singh V B, Srivastava R K, Pandey A K and Dubey S K. 2016. Heterosis—A breeding approach for earliness in yield and yield contributing traits of bitter gourd (*Momordica charantia* L.). *Research in Environment and Life Sciences* **9**(6): 725–27.
- Verma R S, Pratap N, Shekhar R, Singh R P and Vishnoi R K. 2016. Exploitation of heterosis for yield and its components in bitter gourd (*Momordica charantia* L.). *Plant Archives* **16**(1): 403–12.
- Walters T W and Decker-Walters D S. 1988. Balsam pear (*Momordica charantia*: Cucurbitaceae). *Economic Botany* **42**: 286–88.